FALL MIGRATION OF BIRDS AT CHICAGO

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Introduction

This study of fall migration is the result of a daily census of land birds in Lincoln Park, Chicago, in the five years 1946 to 1950 inclusive. The conclusions reached are based mainly on the census record of birds that migrate chiefly at night. This paper is a regional study of grounded migrants, most of which arrived during hours of darkness. My conclusions may or may not apply to day migrants and to migrating birds in other regions.

Lincoln Park lies in a 4½ mile strip along the shore of Lake Michigan, the strip averaging about ½ mile wide. The southern boundary is along North Avenue, 2 miles north of the business center of Chicago. The study area was confined to the southern part of the park, south of Diversey Parkway. The 1¾ mile route traversed each morning meandered so as to include the localities most frequented by the various types of land birds. The route varied somewhat, depending on the season and weather. The census was taken each day between 6:30 and 8:45 a.m. during the principal migration period. The daily time spent afield decreased as migration waned into November, when days are short and birds few in number. On Sunday more time was available and the route was traversed at a more leisurely pace. The observations cover the periods August 1 to November 30 in each of the five years.

Some of the variations in this census record are due to purely chance differences in the number of birds present in the study area from day to day, and from season to season, and to the chance differences in the number of birds present which are seen by the observer. This fortuitous factor is most important in day-to-day counts, and in the yearly records of species seen in small numbers; its effect is reduced in the larger counts of the more abundant species. In this study the major differences in the daily and yearly counts of the more abundant species are regarded as mostly not fortuitous. Slow changes in bird population are known to take place and sudden changes in the populations of certain species have occurred due to special causes, but I have arbitrarily assumed that the autumn populations of the species involved were approximately the same in each of the five years.

Migration routes are believed to be relatively constant year after year. Birds nesting in a given area normally migrate southward within a certain zone or band of territory, and radical departures from such normal migration routes must be uncommon for most species. The bird waves that characterize the autumn migration, the wide variation in the season counts

of the abundant species, and other features of the census record are believed to be due chiefly to variable weather conditions, and particularly to the invasion of the north-central states by great masses of relatively cold northern air, preceded by cold fronts. This conclusion is reached from a study of the Daily Weather Map for each day, in connection with the Lincoln Park census records, and additional weather data published in the Monthly Weather Review. Also essential was the record kept by the writer of the time of important weather changes at Chicago.

Brief References to other Migration Studies

The importance of the relation of bird migration to wind direction and the cyclonic circulation has only been recognized in recent years. McMillan (1938:402–403) stated "the general hypothesis that, whenever possible, migrating birds ride the wind" and Landsberg (1948) used the expression "pressure-pattern flying" for the tendency of birds to take advantage of tail winds in long distance flights, just as aircraft do. This has been confirmed recently by the notable study of nocturnal migration by Lowery (1951) based on telescopic night observations at 34 stations over a wide area east of the Great Plains and south to Yucatán. He finds that a striking correlation exists between air currents and the direction of night flights, and that the flow of migration is, in general, coincident with the flow of air. Lowery's study was restricted to the spring migration, but this correlation probably applies equally in the autumn. Also important is his discovery that most night migrants utilize less than half of the night for their migratory flights, the bulk of night migration ordinarily being between 9 p.m. and 2 a.m. This is an important limiting factor on the distances ordinarily covered during night flights.

The relation of spring migration to weather phenomena has been discussed and the literature reviewed by Bagg, *et al.* (1950), who conclude that during the period of spring migration, pronounced movement will take place into or through a given region during the interval between the passage of a warm front and the subsequent arrival of a cold front. The winds are southerly in these meteorological areas, sometimes strong. These authors distinguish onrushing waves impelled forward by favorable conditions and arrested waves, which are onrushing waves grounded by adverse weather conditions as the cold front approaches, or by quasi-stationary fronts encountered.

Detailed studies have been made of the fall migration of hawks. Allen and Peterson (1936) found at Cape May, New Jersey, that a NW wind of fairly strong or strong force is almost certain to be accompanied by a large influx of migrant hawks and many smaller land birds. Stone (1937:41, 52–53, 262–263) says of the same region that the great flights are always coincident with a NW wind and a falling temperature, and after shifts to a NW wind the whole Cape May Point area will be deluged with birds, these remarks applying not only to hawks, but to kingbirds, flickers, Woodcock (*Philohela minor*), warblers, and others.

The autumn hawk migrations of 1934-1938 at Hawk Mountain, Pa., were studied by Broun (1939). He noted that the most remarkable flight was during 3 days of NW wind following the passage of a hurricane up the Atlantic coast in September, 1938. His daily records for September and October show that 61.9% of the hawks counted were seen on days of NW to NE wind. The NW-NE wind days show an average count

of 340, which was 2.5 times the 134 average count for days of other wind directions. The later, November records are irregular, with 17.9% of the hawk count on days of NW-NE wind.

Fishers Island, at the east entrance to Long Island Sound, is one of three stepping stones in the migration route of hawks (mostly Sharp-shinned Hawks, *Accipiter striatus*) flying from eastern New England southwest to Long Island. The Fergusons (1922) counted 42 flights during 5 fall seasons, of which 30 were with NW wind and 5 with winds NW to NE. In some cases the hawks flew high with NW wind when the surface wind was NE.

Reports on fall migration published in *Audubon Field Notes* contain comments on the relation of weather to migration. Concerning the 1951 period in the New England region, Griscom (1952:5) said, "There were no less than 17 marked cool waves with northwest winds from July 31 to Oct. 21; as a result the whole eastern coast was flooded with land-bird migrants in wave after wave, producing a huge list of species, and many remarkably high daily counts of individuals." In contrast, Griscom (1948:4) said the 1947 fall migration "was as dull and uninteresting as any in the memory of the present generation," due to the abnormally hot weather from August to October, and the scarcity of storms and cool waves, which resulted in a lack of bird waves, the migrants dribbling through day by day. In reporting on the New York region for the same year, Nichols (1948:5) also correlated the warm autumn weather with the late arrival and uniform flow of migrants, until October cool fronts from the northwest brought migration waves. The similarity of the 1947 migration at Chicago will be discussed later.

Williams (1948, 1949, 1950) has made the most important correlations between fall bird migration and cold fronts in his reports on the south Texas region. He associates the principal migration periods or waves appearing in the Texas coast region with the arrival of "northers" and other cold fronts, with NW to NE winds prevailing at the time of influx. For 1947 he listed 20 cold fronts in July to December and recorded their effects on migration; for 1948 he listed 13 cold front periods, stating that "except for a few straggling individuals, the migration occurs in a series of pushes that involve many individuals and species . . . . The optimum condition of migration is an advancing cold front with falling (not necessarily low) temperature and precipitation in the area north of Texas." Williams listed 17 fall migration periods or waves for the Houston area in 1949, each during a period of northerly winds following the advance of a cold front. He correlates these migrations with temperature drops at Pierre, South Dakota (1050 airline miles from Houston), and Minneapolis, each of which followed the passage of a NW cold front through the upper Mississippi Valley. The writer's Lincoln Park August to November records show migration waves during the periods of northerly winds following the arrival of these same cold fronts at Chicago. There is no evidence that temperature drops were the principal motivating factor that caused these migratory movements. During the spring migration important bird waves are always associated with southerly winds, generally at least moderately strong: they are not induced by rising or high temperatures alone when not accompanied by southerly winds. In the absence of contrary evidence, it seems likely that the fall migrants likewise merely take advantage of favorable winds, whenever possible, to make their long migratory flights. These northerly winds follow the passage of cold fronts and in the northern states and Canada are almost invariably accompanied by temperature drops. But the

writer believes that the favorable wind is the critical factor, particularly in the case of migration waves of small land birds migrating at night in August and September when the temperature effect of a cold front passage is usually quite moderate. The temperature factor may dominate in October and November, when sharp drops to sub-freezing frequently occur.

General Relation of Weather and Migration in Chicago Region

The weather of the Mississippi Valley region is dominated during most of the year by the movement of great masses of relatively cool or cold air coming usually from the north or northwest and masses of warmer air, often of tropical origin, coming from the south. The boundaries between these air masses are called fronts. A cold front is the boundary of relatively cold air advancing into an area occupied by warmer air; it is the advancing edge of the cold air mass. Its arrival at a given point is usually followed by a change of wind from a southerly to a northerly direction. These cold air masses are areas of high barometric pressure, called anticyclones, or merely Highs. (The period of northerly wind following the passage of a cold front will be referred to hereafter as a "cold front period.")

The southward migration of birds in autumn is favored during the period soon after the passage of a cold front through the Chicago area, when the winds are generally NW to N. Most autumn migration waves are of the onrushing type. When storm centers pass south of Chicago, conditions adverse to migration may continue for some time after the wind shifts from NE to N and NW, and in such cases the migratory movement is delayed until the storm passes on and better flying conditions prevail. Such delayed waves are frequent in autumn, but arrested waves are uncommon.

Many weather cycles are complicated and prolonged. Highs moving across the continent may be marked at a given station by more than one cold front. These air masses are really great currents that may flow southward and eastward for several or many days, with minor interruptions and phases, each of which may be marked by a new cold front. A discussion of these complications will be avoided. A person without weather maps merely observes the changes in wind direction and other weather phenomena. The changes from southerly to northerly wind directions generally follow the arrival of the important cold fronts. But if a storm center is passing to the south, as the cold front approaches the wind will shift to E and NE, and then N and NW as the Low center moves eastward.

As a general rule the big migration waves of a given species occur during cold front periods in the early or middle part of that species' migration period. Later the number of birds remaining in the north is so reduced that only relatively small migratory waves can originate there. This obvious fact is of major importance in explaining why the total number of birds of a

given species seen varies so greatly from year to year, a subject discussed later. Following the arrival of a cold front and northerly winds bringing a wave of birds of a given species, the number seen in the study area ordinarily decreases for several days, down to a number more usual for the species at that time of year. The balance between arrivals and departures determines whether the observer finds an increase in his study area on the morning after a cold front passage. Toward the end of a species' migration period the departures commonly exceed arrivals.

The period of strong cyclonic circulation generally begins at some time in September and ends in May. During these months the weather is dominated by the procession of Lows and Highs, storms and cold fronts, that move across the continent in a general easterly direction. During the summer the weather conditions are much more static, the air circulation is more sluggish, and the storms and cold fronts mild compared to the vigorous phenomena of later months. The autumn migration begins during this static summer period and much of the warbler migration has passed before the strong circulation of autumn is established. So the early part of fall migration is in a separate period, not so much dominated by cold fronts.

The principal autumn migration waves into the Chicago region occur during September and the first 20 days of October. The later waves involve fewer birds because by late October almost all of the migratory birds (at least of the species here studied) have already left the regions north of Chicago. The important waves are clearly related to favoring winds, but the sharp drop in temperature that usually follows a cold front passage may be a factor in causing birds to start off on a migratory flight. The cold fronts followed by important bird waves in the period September 1 to October 20 seldom bring temperatures low enough to force the birds to leave the regions north of Chicago. Only a few stragglers remain in the north to be driven south by the late cold fronts which bring the first wintery weather.

The 1949 record will be cited. No freezing temperatures were recorded prior to September 28 at Green Bay, Sault Ste. Marie, Duluth, International Falls, or Winnipeg, and yet at that date the warbler count (exclusive of Palm, *Dendroica palmarum*, and Myrtle Warblers, *D. coronata*) in Lincoln Park had reached 3,525, and later only 258 additional birds were counted. It is obvious that, in 1949, these warblers were not really forced to leave the regions north of Chicago because of cold weather. And in the same year no temperatures under 24 degrees Fahrenheit were recorded at any of these northern stations until October 23, yet at that date most of the later migrants had already passed Chicago, where no freezing temperatures had yet been recorded.

Cold fronts entering the Chicago region may be divided, as regards bird migration, into three groups: (1) cold fronts followed by NW winds, (2) cold fronts followed by NW-NE winds, and (3) cold fronts followed by NE winds. The cold fronts of these types, including some very mild ones, that reached the Chicago region during the period August 10 to November 10 in each of the five years were as follows:

	1946	1947	1948	1949	1950	Totals
NW type	7	6	4	13	8	38
NW-NE type	5	9	3	2	9	28
NE type	2	2	5	4	3	16
Totals	14	17	12	19	20	82

Cold Fronts Favoring Migration into Chicago Region

Cold fronts with NW winds are the most important type as regards bird migration in the Chicago region. The barometric High (anticyclone) and the great air mass which it represents usually moves from western Canada across the northern Great Plains and on to the southeast, passing west and south of Chicago. The arrival of the cold front at Chicago is ordinarily marked by a change from southerly to NW wind. The moderate to strong NW wind generally continues for at least 24 hours, and in many cases for several days. As the High center moves on to the southeast, the wind shifts back to a southerly direction, usually SW.

Cold fronts with NW-NE winds are only a variation of the preceding type, and are always the result of High centers passing north of Chicago. The High center generally moves from the west along the southern boundary of Canada, or from northwest Canada to the upper Great Lakes region and eastward. The southerly wind shifts to NW or N when the cold front reaches Chicago; then generally within 6 to 12 hours the wind shifts on to NE as the High center moves eastward. The NE wind may continue for several days. In many cases storm centers pass south of Chicago as the cold front approaches, which causes the wind to shift through the E and NE to N or NW as the storm passes. The principal flight of birds appears to accompany the initial phase of NW or N wind.

The effect of a large number of these cold fronts and the periods of NW-N winds that followed on the migration of nine of the abundant species is shown in Table 1, which shows for each species the average count on the two mornings preceding arrival of the cold front at Chicago, and on the three mornings following. The average effect is striking, but for individual cold front periods the increase for some of the species is much greater than these averages.

Cold Fronts with Northeast Winds

Cold fronts followed by NE winds are generally not accompanied by bird waves in the Chicago region. They result from air masses moving from northern Canada to the Lake Superior region or farther east. The path of the air mass movement generally lies farther east than the air masses causing cold fronts with NW-NE winds. The High center passes north and east of Chicago. These cold fronts cause the wind at Chicago to shift from a southerly direction to NE, and the NE wind may continue for several days. Such cold fronts generally extend in a west to east direction, moving directly south or even southwest as they approach Chicago. In the types described in the preceding section, the cold fronts generally extend southwest to northeast and approach Chicago from the northwest.

In the Chicago region cold fronts with NE winds are characteristic of the summer period of static weather. They are common during August and early September, and much less frequent later, after the strong cyclonic circulation becomes established. Cold fronts of this type are followed by decreased bird counts in Lincoln Park; during the 5-year period no marked bird waves followed any of these cold fronts. Table 2 gives the warbler counts on the two mornings before and two mornings after arrival of 7 NE cold fronts in August and September. Table 3 gives data for 3 October cold front periods of this type, including both combined warbler counts and the combined counts of Fox Sparrow (*Passerella iliaca*), White-throated Sparrow (*Zonotrichia albicollis*), Slate-covered Junco (*Junco hyemalis*), Tree Sparrow (*Spizella arborea*), Hermit Thrush (*Hylocichla guttata*), Brown Creeper (*Certhia familiaris*), and Golden-crowned Kinglet (*Regulus satrapa*) ("Sparrows etc." in tabulation).

Barrier Effect of Lake Michigan

Autumn migration waves at Chicago are commonly associated with cold fronts invading the central states, accompanied by strong NW to N winds. No pronounced waves occurred during intervening and static weather periods, and this five-year study has produced no evidence that birds migrate across Lake Michigan in any appreciable numbers. Cold fronts accompanied only by strong NE winds never brought migration waves to Lincoln Park. Strong NE winds at all times during both fall and spring, particularly if cold, tend to drive the birds out of the park. During periods of lighter NE wind the moderate increase in bird counts is interpreted as merely the result of southward flights in the region just west of Lake Michigan. With strong NE winds in the Lake Michigan region, birds migrating from areas north of Chicago would naturally tend to fly southwest with the wind. and thus pass west of Chicago.

Table 1

Average Morning Counts in Relation to Passage of Cold Fronts

	No. of Fronts	Before Arrival		After Cold Front Passage		
		2nd Morn.	1st Morn.	1st Morn.	2nd Morn.	3rd Morn.
Palm Warbler	22	7.0	7.4	42.2	24.5	16.4
Myrtle Warbler	25	17.2	14.1	35.3	27.9	21.6
White-throated Sparrow	28	23.6	24.1	75.1	58.9	35.0
Fox Sparrow	22	3.6	3.9	15.6	13.3	8.4
Slate-colored Junco	30	36.0	33.0	102.1	78.5	50.5
Tree Sparrow	20	8.2	4.7	27.2	18.0	11.1
Hermit Thrush	21	5.2	4.8	16.6	14.7	8.8
Brown Creeper	26	2.1	1.9	6.2	4.9	2.9
Golden-crowned Kinglet	23	6.6	7.3	36.9	32.6	22.2

Table 2

Morning Counts of Warblers during September Cold Front Periods of Northeast Wind Type

Date of Cold Front	Sept. 11 1946	Sept.24 1947	Aug. 30 1948	Sept. 2 1948	Sept. 13 1948	Sept. 20 1948	Sept. 16 1950
Before arrival							
2nd Morning	98	125	—	100	217	437	78
1st Morning	60	123	128	243	236	217	63
After arrival							
1st Morning	57	38	136	151	175	151	43
2nd Morning	79	53	102	60	122	138	72

Table 3

Morning Counts of Warblers and Other Birds during October Cold Front Periods of Northeast Wind Type

Date of Cold Front	Oct. 15, 1949		Oct. 14, 1950		Oct. 21, 1950	
	Warblers	Sparrows etc.	Warblers	Sparrows etc.	Warblers	Sparrows etc.
Before arrival						
2nd Morning	122	135	76	310	32	243
1st Morning	76	130	50	128	19	62
After arrival						
1st Morning	61	92	39	95	14	73
2nd Morning	37	35	23	50	12	33

The converse must also be true. Migration waves moving southeast with strong NW winds must be largely stopped when the west shore of Lake Michigan is reached. Cold fronts followed by strong NW winds result, I think, in concentrations of birds in the area just west of Lake Michigan. Many of the birds arriving in the Chicago area during a cold front period are slow to leave, and the same is true of birds along the west shore farther north. The gradual southward migration of birds from the shore zone north of Chicago results in an abnormal number of new daily arrivals in the Chicago area. The result is that for many days following such a migration wave the count of the species involved will be abnormally large at Chicago, if the weather is mild and the birds do not suddenly leave during later cold front periods.

Early autumn flights of swallows, Nighthawks (*Chordeiles minor*), and hawks are observed frequently along the west shore of Lake Michigan in the Chicago area. Beebe (1933) described the migration of hawks from Ontario southwest through Upper Michigan to the north shore of Lake Michigan, and thence west and south along the lake. Jung (1935:75) says that farther south in Door County, Wisconsin, these hawk flights are confined chiefly to a narrow shore belt only ¼ to ½ mile wide. No general correlation between these day migrations and wind direction and other weather conditions was made.

An August flight of more than 10,000 Purple Martins (*Progne subis*) was observed by Smith (1908) west of Holland, Michigan. The birds flew with a moderately strong NE wind and were restricted to a strip about one quarter mile wide along the east shore of Lake Michigan. The wind continued NE and next morning abundant arrivals of warblers and flycatchers were noted, the first migration wave of the season. In August, 1904, a flight of more than 1,000 hawks was observed at the same locality, also during a period of moderately strong NE wind. This record of a pronounced migration wave on the second morning of a NE wind period contrasts sharply with the relation between migration waves and wind direction observed on the west side of the lake.

Concentrations of migrants are produced along the Atlantic coast during periods of strong NW winds, particularly at Cape May, New Jersey, where the work of Allen and Peterson (1936) and Stone (1937), already referred to, has shown that strong NW winds blowing across the usual line of southward inland migration produce great concentrations of migrants. Even the hawks do not attempt to fly on south across Delaware Bay during these periods. These writers also say that night migrants that flew beyond the coast line are sometimes seen in early morning flying in from the open ocean

against the wind, and Stone records Woodcock and warblers flying in low from the sea at night.

Lakes Ontario and Erie are at least partial barriers to the southward autumn flight of day migrants. Baillie (1950, 1952:14–15) refers to the traditional SW direction of flight of hawks, Flickers (*Colaptes auratus*), and Blue Jays (*Cyanocitta cristata*), along the north shore of Lake Ontario in the Toronto area. He records large westerly flights of the birds farther west in the vicinity of Port Stanley, London, and Chatham, Ontario. But to what extent these lakes hinder the southward movement of night migrants is unknown.

At this point other important questions relating to migration through the Chicago region will be mentioned. What route is ordinarily followed by birds nesting north of Lake Superior? Do they cross Lake Superior, or do they migrate east or west around it? And to what extent do birds other than hawks migrate from Ontario westward through the Sault Ste. Marie area to Upper Michigan, and then south through eastern Wisconsin? The answers to these questions probably account for some of the irregularities in the numbers of northern nesting birds seen in Lincoln Park. This is particularly true of the Golden-crowned Kinglet and a number of the warbler species that nest principally east of Manitoba.

The westward route through the Sault Ste. Marie area may be important in the southward migration of many species during periods of easterly winds in the upper Great Lakes region. Strong NW cold fronts would favor migration south across the Straits of Mackinac to Lower Michigan, or eastward along the north side of Lake Huron and Georgian Bay. The westward route could be followed easily during the late summer period of relatively static weather, before the strong cyclonic circulation of autumn is established. In 1947, no strong NW cold fronts invaded the Great Lakes region until mid-September. In 1950, there was none from September 3 to October 2, and in 1948, none from September 8 to October 1. The first strong NW cold front of 1949 reached Chicago on September 18. Easterly winds during these and many other shorter periods were probably favorable to migration along the westward route from Ontario through the Sault Ste. Marie area to Upper Michigan.

Migration Waves at Irregular Times

During this study there were few migratory waves that arrived at irregular times in relation to cold fronts, in spite of the complex relation in many periods between storm centers and cold fronts. In several cases the arrival of a migratory wave appears to have been delayed by the passage of an extensive storm through the region. At least two minor waves were classified

as arrested waves, that is, the migrating birds were grounded by adverse weather in the Chicago area. On two occasions a considerable flight of birds preceded the change in surface wind direction to NW, and, therefore, arrived in advance of the time when an observer would normally have expected the arrival of birds flying with the NW wind following the passage of an advancing cold front.

An advancing cold front is characterized by more or less interfingering of air currents. In some cases an air current from the NW overlies at no great height a SW surface wind. Such a condition might explain the arrival of a migration wave before the surface wind shift. Some cold fronts move slowly or stop advancing, and migrating birds might fly on into the zone of southerly winds, beyond the surface wind shift line of the cold front. Atmospheric conditions along slow moving or stationary cold fronts are usually not turbulent, and cloud conditions and lack of precipitation may permit the flight of birds.

Complex Weather of September—October, 1946

The weather record for the north-central states in September and October, 1946, was complex. A number of storm centers passed through the Chicago region or west of it. Four of them were followed by cold fronts that caused no shift to NW or N winds at Chicago. Six cold fronts from the northwest or north died out in central or southern Wisconsin, and two others lost force and became static as they reached Chicago, their progress stopped by storms developing in or passing through the central states. Only five cold fronts from the northwest or north passed through the Chicago region with any force, and some of these were mild.

This was naturally an autumn of few bird migration waves in the Chicago region. The eight cold fronts that died out or lost force as they reached central and southern Wisconsin undoubtedly brought many migratory birds into the region not far north and northwest of Chicago. Such concentrations of migrants would disperse gradually as the birds continued their migration southward. This is indicated by the very irregular record of birds in Lincoln Park during these months. The first September cold front with NW to N wind reached Chicago on September 28, and as a result the counts of species migrating largely during the last half of September and early October were low, and their median dates were late. (The median date is the date on which the season count of a species reached half of the season total.) In October, four cold fronts reached Chicago and six others died out or lost force in southern and central Wisconsin. So the counts of species migrating principally in October were relatively large.

Western Palm Warbler Migration

	1946	1947	1948	1949	1950
Total count	315	1055	1476	559	240
Median date	Oct. 8	Oct. 2	Sept. 19	Oct. 1	Oct. 4

The Western Palm Warbler (*Dendroica p. palmarum*) nests from northern Minnesota north along the west side of Hudson Bay to northern Manitoba, and west to the Mackenzie Valley and casually to Alberta. With static weather the birds migrate leisurely southward through the Missouri and Mississippi valleys and the bulk of the migrants probably pass through the region west of Chicago. The year 1950 was an extreme example, with no cold fronts with strong NW winds invading the north-central states during September. During this period the daily count of Palm Warblers never exceeded 20, and the total was small. The early October cold fronts were too late in the migration period of the Palm Warbler to be accompanied by great flights, the peaks being 25 on Oct. 3 and 55 on Oct. 9. So the total count for 1950 was low chiefly because of the sequence of weather, and particularly the lack of strong NW winds during the first half of the Palm Warbler migration period.

The year 1948 was an opposite extreme. A cold front followed by strong NW winds swept down from Alberta at the very beginning of the migration period of the Palm Warbler. This favorable wind brought a great flight of these warblers into the Chicago region, with counts of 134 and 150 on September 9 and 10. Many of the arriving birds must have remained for a considerable period of time, departing gradually. This same cold front must have brought comparable flights into the region to the north along the west side of Lake Michigan, and there was probably an unusual concentration of Palm Warblers along the west side of Lake Michigan as a result of its barrier effect. So in the days that followed a large number of birds were migrating south through the Chicago area, and each succeeding cold front (on September 13, 20, and 30) was followed by a sharp increase in the daily count. From September 11 to October 4, the average daily count was 41. The net result was that the strong cold front from the NW at the very beginning of the Palm Warbler migration resulted in a large total count for the season.

The year 1947 was similar. The migration as a whole was late that year, as will be pointed out later. A prolonged heat wave was finally ended on the evening of September 14 by a cold front followed by a migration wave on September 15, including 23 Palm Warblers. A week later a strong cold front swept down from northwest Canada, bringing a wave of Palm Warblers with a count of 140 on September 22 and an average daily count of 46 for 16 days thereafter. The result was a season total much above average.

The total count in 1949 was intermediate. The early cold fronts on September 13 and 19 were mild and not accompanied by waves of fall migrants. A stronger cold front on September 27, bringing peaks of 45 and 50, was evidently too late to be accompanied by a great wave of Palm Warblers.

The complexity of the 1946 autumn weather has been discussed. No cold fronts with NW or N winds reached Chicago in September until September 28, with stronger cold fronts on October 7 and 11. The lack of strong cold fronts with favoring NW winds during September resulted in a low count of Palm Warblers for that year.

Myrtle Warbler Migration

	1946	1947	1948	1949	1950
Total count	955	528	1426	1942	713
Median date	Oct. 4	Oct. 3	Oct. 4	Oct. 7	Oct. 13

The Myrtle Warbler breeds westward to Alberta, British Columbia, and Alaska. The years of highest counts are those marked by cold fronts with strong NW winds during late September and early October, but this relation is not as striking as in the case of the Palm Warbler. Important waves of Myrtle Warblers do not appear so early as those of the Palm, the migration of the former under the most favorable conditions being somewhat later. Day to day observations show that Myrtle Warblers remain in Lincoln Park longer than Palm Warblers, probably because of more favorable feeding conditions for the Myrtle Warbler in the park. If a wave of Myrtle Warblers arrives early in the migration period of the species, the daily count generally continues near the peak for four or five days.

A strong NW cold front on September 21, 1949, caused successive daily counts of 75, 60, 75, and 75. The next NW cold front on September 27 was followed by an average daily count of 61 for seven days. These strong cold fronts in 1949 early in the Myrtle Warbler migration period, coupled with four later cold fronts in October, were mainly responsible for the high season total. In 1948, the September weather was static after the September 8 cold front that brought the big Palm Warbler wave. From September 20 to 29 a NE wind blew continuously, with a gradual increase in Myrtle Warblers; then a strong cold front October 1 resulted in a count of 622 in eight days. Later cold front periods added their quotas and so the 1948 count was large.

The extremely low 1947 count was connected with the prolonged heat wave until mid-September. The big Palm Warbler wave followed the September 21 cold front, but conditions during the next two weeks resulted in only a small migration of Myrtle Warblers at Chicago. The static September weather of 1950 resulted in an early scarcity of Myrtle Warblers even more

pronounced than in the case of the Palm Warbler. Most of the birds came with cold fronts in the last half of the normal migration period on October 2, 7, 11, and 19. The season count was low and the median date later than usual.

Migration of Sparrows

	1946	1947	1948	1949	1950
White-throated Sparrow					
Total count	1436	2181	2000	1656	1116
Median date	Oct. 8	Oct. 8	Oct. 9	Oct.4	Oct. 7
White-crowned Sparrow (*Zonotrichia leucophrys*)					
Total count	162	179	136	64	20
Median date	Oct. 12	Oct. 2	Oct. 8	Oct. 5	Oct. 9
Fox Sparrow					
Total count	393	224	456	233	207
Median date	Oct. 8	Oct. 16	Oct. 19	Oct. 11	Oct. 14
Slate-colored Junco					
Total count	3465	4204	5185	2105	2076
Median date	Oct. 21	Oct. 24	Oct. 22	Oct. 18	Oct.20
Tree Sparrow					
Total count	143	279	1074	51	101
Median date	Nov. 2	Nov. 2	Nov. 1	Nov. 3	Nov. 3

The sparrows listed nest north to the limit of trees and the Tree Sparrow beyond in the barren grounds. They (excluding western subspecies probably not involved in this study) breed west to Alberta and the Mackenzie Basin, the Slate-colored Junco and Fox Sparrow extending on to northwestern Alaska. Their migration through the Chicago region would be expected to follow in general the Palm Warbler pattern. With static weather the birds would migrate at a leisurely rate southward and most of the birds nesting in the western part of their breeding range would pass west of Chicago. But cold fronts sweeping down from the northwest during the early part of their migration periods would result in shifting more of these western birds into the area east of the Mississippi, and the barrier effect of Lake Michigan would be effective in causing concentrations along the western shore.

The big Palm Warbler years were 1947 and 1948 because of strong cold fronts from the northwest early in their migration period. For much the same reason these were also the years of great abundance at Chicago of the northern nesting sparrows. The low sparrow counts in 1949 and 1950 were connected with the warm autumn weather in both years. October 1949 was the warmest October of record at Chicago and October 1950 the second warmest. In both years there were few strong cold fronts during the period September 15 to October 15. The percentage of days with southerly and easterly winds was unusually high. The count of juncos was 100 or more on

only two days in 1949 and six days in 1950, compared with 27 days in 1948 and 19 days in 1947.

The large sparrow counts in 1947 and 1948 resulted from a succession of strong cold fronts. The 1947 sequence was most favorable for the White-throated Sparrow; beginning with the September 21 cold front that brought the big wave of Palm Warblers, the White-throats reached a peak of 225 on September 30, when the junco migration had barely begun. In 1948 the weather sequence favored the juncos, which were very abundant until mid-November; and also the Fox Sparrow, whose median date was later than usual. No explanation is apparent for the relative scarcity of Fox Sparrows in 1947. The large 1946 count of Fox Sparrows was the result of very large counts following cold fronts on September 28 and October 7.

Tree Sparrows are abundant in Minnesota and Iowa during the fall migration. This species seems to prefer to migrate through the more open country, west of Chicago. It was counted in large numbers only in 1948, when the cold front sequence apparently caused many sparrows nesting in the western part of their species' breeding ranges to migrate farther to the east than usual. The Tree Sparrow is a late migrant and in each year the principal flight came with a cold front around November 1. The high count in 1948 resulted largely from a cold front on October 22, followed by a peak count of 100 and average daily counts of 51 for eight days, and a cold front October 31 with peaks of 100 and 155 and an average of 71 for seven days. The highest daily count of the other four years was 40.

Other Important Late Migrants

	1946	1947	1948	1949	1950
Hermit Thrush					
Total count	234	316	456	248	332
Median date	Oct. 13	Oct. 13	Oct. 11	Oct. 5	Oct.11
Brown Creeper					
Total count	98	159	257	171	138
Median date	Oct. 19	Oct. 19	Oct. 8	Oct. 12	Oct. 10
Ruby-crowned Kinglet (*Regulus calendula*)					
Total count	246	181	142	230	146
Median date	Oct. 11	Oct. 19	Oct. 16	Oct. 12	Oct. 16
Golden-crowned Kinglet					
Total count	888	1414	237	873	754
Median date	Oct. 17	Oct. 19	Oct. 16	Oct. 12	Oct. 16

The migration of the Hermit Thrush in the Chicago region resembles that of the Palm Warbler and the sparrows mentioned above. The peak counts of 40 to 60 birds all resulted from strong cold fronts from the northwest on October 13, 1947, October 1, 8, and 16, 1948, and October 7 and 11, 1950.

The average daily count was high after each of these waves, as some of the birds apparently remained in the park for a week or more. The cold front of September 27, 1949, brought a moderate flight of Hermit Thrushes, but there were no later cold fronts of consequence until October 21, so the 1949 count was low. The 1946 record was similar, a September 28 cold front bringing some Hermit Thrushes, but few came into the park with the cold fronts of October 7 and 11.

The migration of the Brown Creeper is definitely associated with air masses sweeping down from the northwest and north. The strong cold fronts during October generally bring small flights with peak counts of 10 to 20 birds. The record resembles those of other October migrants, with the highest count in 1948.

The record of the Golden-crowned Kinglet shows an average yearly count of 833, with notable departures from this average only in the 1947 count of 1414, and the extremely low 1948 count of 237. This is remarkable because the autumn of 1948 was characterized by a succession of strong cold fronts and peak or near-peak counts of all other late migrants. The eastern race of the Golden-crowned Kinglet nests from Manitoba and Minnesota eastward. The fact that this kinglet was so scarce in 1948 suggests that many of the birds that ordinarily migrate down the west side of Lake Michigan were deflected to the east of their usual route by the weather succession. The migration of these kinglets may ordinarily involve a southwesterly movement around the west end of Lake Superior, and perhaps a migration from the northeast through the Sault Ste. Marie region and thence down the west side of Lake Michigan. The 1948 migration period was unfavorable for such southwesterly movements.

The unusually large 1947 count of Golden-crowned Kinglets may have been related to the prevailing easterly winds in the Lake Superior region during late September and October. At Sault Ste. Marie the October hourly wind record was 63% SE to NE and 20% W to NW; at Duluth the record was 55% E to NE and 18% W to NW. In 1947 the Golden-crowned Kinglet was first seen in Lincoln Park on September 25, and arrived in force on September 30. The waves of Golden-crowns were associated with other migrants that accompanied NW to N cold front winds.

Early Migration Period

The migration of the warblers is presented as representative of the early part of the fall migration (excluding the late migrating Palm and Myrtle warblers already discussed). The warblers comprise the great majority of all migrating land birds at Chicago during August and much of September.

Most warblers do not remain in their northern nesting grounds until driven south by cold weather. The migration of most species begins in late July or early August. This applies both to northern nesting birds and those nesting farther south. The Yellow Warbler (*Dendroica petechia*), for example, leaves its nesting areas around Chicago in late July or early August, and birds nesting farther north migrate through the region during August. This is in the hot part of summer when insect food is most abundant. The Yellow Warbler is not common at Chicago in September.

TABLE 4

SUMMARY OF TOTAL WARBLER COUNT 1946–1950
(*Exclusive of Palm and Myrtle Warblers*)

	1946	1947	1948	1949	1950
Aug. 1–10	0	7	27	0	15
11–20	32	3	212	3	46
21–31	565	162	981	518	241
Sept. 1–10	1,131	465	1,557	1,500	1,485
11–20	788	822	1,760	1,074	1,118
21–30	695	384	534	458	612
Oct. 1–10	106	203	87	179	197
11–20	37	35	22	40	15
21–31	8	11	2	11	0
November	4	5	3	0	0
Totals	3,366	2,097	5,185	3,783	3,729
Median Date	Sept. 10	Sept. 15	Sept. 10	Sept. 10	Sept. 11

The warbler migration begins during the summer period of static weather and much of the migration passes in most years before the strong cyclonic circulation of autumn is well established, as already pointed out. Most summer cyclones and anticyclones are not strongly developed circulations, and the summer cold fronts are ordinarily mild. But there are exceptions; great masses of cool Arctic air do sometimes sweep down from the north during the summer. An important cold front at the beginning of August in 1948 appears to have had a profound effect on the autumn migration in that year; in 1947 the lack of any strong cold fronts until mid-September made that a year of opposite extreme.

A summary of the warbler count for each year is given in Table 4. The average number of warblers counted, exclusive of Palm and Myrtle, was 3,632 per year. The counts in 1946, 1949, and 1950 were about average, with a notably high count in 1948 and a very low count in 1947. The median dates were remarkably uniform, except 1947, which was a little late. The

record of the more abundant species is given in Table 5, with median dates. The census of the uncommon warbler species with median dates for all birds seen during the five years, is as follows:

	1946	1947	1948	1949	1950	Total	Median Date
Prothonotary (*Protonotaria citrea*)	—	—	2	—	—	2	Aug. 13
Louisiana Water-thrush (*Seiurus motacilla*)	3	11	17	—	—	31	Sept. 1
Canada (*Wilsonia canadensis*)	22	10	7	4	3	46	Sept. 1
Mourning (*Oporornis philadelphia*)	3	3	—	—	—	6	Sept. 5
Golden-winged (*Vermivora chrysoptera*)	1	—	4	—	—	5	Sept. 7
Connecticut (*Oporornis agilis*)	2	5	2	—	4	13	Sept. 7
Parula (*Parula americana*)	3	1	—	3	—	7	Sept. 15
Pine (*Dendroica pinus*)	—	1	5	—	—	6	Sept. 16
Kentucky (*Oporornis formosus*)	—	1	—	—	—	1	Sept. 16
Black-throated Blue (*Dendroica coerulescens*)	13	7	11	—	15	46	Sept. 22
Orange-crowned (*Vermivora celata*)	20	14	1	28	10	73	Oct. 13

The season counts of warblers and other species correctly show the relative frequency of observation, but not the actual abundance of the birds. For example, the Redstart finds the park a congenial place to linger, and many individuals probably do remain for a week or more. But the Blackburnian always appears to be in haste to move on. So the total five-year Redstart count of 4,571 does not mean that it is about 14 times more abundant as a fall migrant than the Blackburnian, with a total count of only 335. The large season counts give an exaggerated picture when compared to the low counts, as regards actual abundance. This applies not only to comparisons between species, but also to comparisons of large and small yearly counts of the same species.

Early Migration Period in 1947

The upper Mississippi Valley region experienced a heat wave in the late summer of 1947. The average August temperature at Chicago was 8.6° above normal and for 14 stations farther north from Alpena, Michigan, to Williston, North Dakota, the average was 7.0° above normal. The heat wave continued in September with equally abnormal temperatures, until finally broken by

TABLE 5

CENSUS RECORD OF THE ABUNDANT WARBLER SPECIES

Total season counts and median dates

	1946	1947	1948	1949	1950	5-yr. period
Yellow	20	35	160	24	58	297
(*Dendroica petechia*)	Aug. 14	Aug. 24	Aug. 17	Aug. 29	Aug. 14	Aug. 18
Blackburnian	103	31	95	41	65	335
(*Dendroica fusca*)	Sept. 1	Sept. 7	Sept. 2	Sept. 6	Sept. 4	Sept. 3
Wilson's	19	19	40	16	61	155
(*Wilsonia pusilla*)	Sept. 2	Sept. 8	Sept. 8	Sept. 1	Sept. 4	Sept. 5
Tennessee	263	127	211	232	261	1,094
(*Vermivora peregrina*)	Sept. 8	Sept. 11	Aug. 29	Sept. 6	Sept. 8	Sept. 7
Northern Water-thrush	187	226	392	332	140	1,277
(*Seiurus noveboracensis*)	Sept. 5	Sept. 10	Sept. 3	Sept. 12	Sept. 1	Sept. 8
Black and White	175	102	307	120	70	774
(*Mniotilta varia*)	Sept. 3	Sept. 13	Sept. 11	Sept. 8	Sept. 1	Sept. 9
Redstart	768	661	1,421	967	754	4,571
(*Setophaga ruticilla*)	Sept. 7	Sept. 16	Sept. 7	Sept. 6	Sept. 14	Sept. 10
Blackpoll	554	196	743	641	681	2,815
(*Dendroica striata*)	Sept. 16	Sept. 16	Sept. 8	Sept. 10	Sept. 11	Sept. 11
Bay-breasted	50	10	172	127	185	544
(*Dendroica castanea*)	Sept. 15	Sept. 26	Sept. 12	Sept. 12	Sept. 10	Sept. 11
Cape May	153	28	253	204	420	1,058
(*Dendroica tigrina*)	Sept. 12	Sept. 21	Sept. 9	Sept. 10	Sept. 12	Sept. 11
Magnolia	379	223	547	330	364	1,843
(*Dendroica magnolia*)	Sept. 10	Sept. 20	Sept. 11	Sept. 9	Sept. 9	Sept. 11
Chestnut-sided	160	45	136	150	113	604
(*Dendroica pensylvanica*)	Sept. 20	Sept. 21	Sept. 14	Sept. 8	Sept. 10	Sept. 13
Ovenbird	66	92	165	104	47	474
(*Seiurus aurocapillus*)	Sept. 12	Sept. 16	Sept. 15	Sept. 19	Sept. 13	Sept. 15
Black-throated Green	199	160	275	192	189	1,015
(*Dendroica virens*)	Sept. 10	Sept. 22	Sept. 18	Sept. 17	Sept. 12	Sept. 17
Northern Yellow-throat	103	40	114	112	86	455
(*Geothlypis trichas*)	Sept. 21	Sept. 15	Sept. 15	Sept. 18	Sept. 15	Sept. 17
Nashville	100	49	105	256	203	713
(*Vermivora ruficapilla*)	Sept. 14	Oct. 4	Sept. 21	Sept. 22	Sept. 11	Sept. 19

a eold front that reached Chieago in the late evening of September 14. During all of this long period the Mississippi Valley region was invaded by no important eool air masses from the north; there were no strong eold fronts. The similar weather in the New York and New England regions, and its effeet on bird migration, has already been referred to.

The early migration period at Chicago was uneventful as a result of this abnormal period of late summer heat. There were no migration waves prior to the arrival of the September 14 eold front. Only 17 warblers were eounted prior to August 24, all Yellow Warblers. Later the eount of warblers in-

creased slowly to 52 on August 31 and 90 on September 8, but the census area count did not reach 100 until September 15, when the first strong cold front from the northwest brought a moderate increase, including the first Palm Warblers (23) and a few White-throated Sparrows and kinglets. The next strong cold front, on September 22, brought the wave of 140 Palm Warblers and the first important appearance of Myrtle Warblers, White-throated Sparrows, Fox Sparrows, juncos, and Hermit Thrushes. The season count of warblers (excluding Palm and Myrtle) was extremely low because of the unusual weather conditions up to mid-September. Under static conditions the birds evidently moved south leisurely, making many short flights instead of mass movements stimulated by cold front winds. Large concentrations did not accumulate along the west side of Lake Michigan or elsewhere in the region. The median dates were late.

Early Migrations of 1948 and 1950

The extremely large warbler count (excluding the Myrtle) in 1948 is interpreted as having its origin in the southward movement of a great mass of cool northern air during the first week of August. This and a favorable later weather sequence resulted in a large concentration of warblers in the Chicago region from late August into early October. The warbler count in Lincoln Park exceeded 100 on every day from August 28 to October 4, with a peak of 437 on September 19. The Arctic air mass accompanied a High that appeared on the coast of northwest Mackenzie on July 31, moving southeast to Lake Winnipeg (Aug. 4) and eastern Kentucky (Aug. 7). Northerly winds prevailed over a great area in Canada and the north-central United States during this period, with light frosts in Canada and the Lake Superior region and a low of 51° at Chicago (Aug. 6). Large numbers of warblers probably took advantage of the northerly winds to make migratory flights southward from their nesting grounds. Then the migration continued at a slow rate, except as accelerated by cold fronts reaching Chicago on August 18 and 22. The total warbler count to August 20 was 239, compared to an average of 27 for the other years. The August total was 1220, the average of the other years 398.

Reference has been made to the strong cold front that reached Chicago on September 7, 1948. The early wave of Palm Warblers that followed this cold front was also probably an aftermath of the Arctic air mass that moved southward in early August. The weather sequence, and particularly the strong early September cold front, apparently caused a large southeast movement of warblers, with concentration along the west side of Lake Michigan. Two weeks of warm static weather followed in September, and through-

out this period the daily count of warblers in Lincoln Park was unusually large, averaging 229.

The central and eastern parts of North America were also invaded by a great mass of Arctic air during August, 1950. A strong High appeared in northwest Canada on August 15, one center moving to Georgian Bay (August 18) and east, followed by the principal High center moving from northern Alberta (August 17) to Kansas (August 20) and east. The cold front reached Chicago in the evening of August 17, and was followed by four days of NW wind with morning temperature 48° to 46°, these being the lowest ever recorded at Chicago in August. There were frosts in the Canadian prairie provinces that did great damage to the wheat crop; there were also frosts in the Lake Superior region. In all this area no such August cold wave had ever been recorded before, and everywhere it was accompanied by a long period of NW wind.

This northern air invasion came in mid-August, when the slow southward migration of northern nesting warblers was in progress. It must have caused an early concentration south of their nesting grounds, with the usual shift to the southeast. But the effect of the early cold front was largely dissipated during a seven-week period of summer weather that followed, broken only by a moderate cold front that reached Chicago on September 3, with a warbler count of 185 the next morning. The warbler count averaged 155 during the first 14 September days, but was very low during the last half of the month, exceeding 100 on only three days. So, the 1950 total was only about average.

Migration of Early Warbler Species

A satisfactory analysis of the record of most of the warbler species is impossible because no adequate information is available concerning either the relative abundance of the warblers in different parts of their breeding ranges or their southward migration routes from the different breeding areas. The possibilities of migration across or around Lake Superior, and of westward migration from Ontario through the Sault Ste. Marie area to Upper Michigan and then south through Wisconsin, cannot be evaluated. The variations in season counts of each species have been studied, and also the same figures reduced to a percentage of the total warbler count for the season. Only a few generalizations appear to be justified.

The large season counts of the abundant early migrating warblers are interpreted as related closely to strong NW cold fronts, just as in the case of the later Palm and Myrtle warblers. This seems to be especially true of at least some of the species whose breeding ranges extend far to the west and northwest in Canada and, in some species, even into Alaska, particularly the

Blackpoll, Yellow, Wilson's, Bay-breasted, and Cape May warblers. Above average counts of these are evidently due largely to a favorable sequence of strong cold fronts, with southeast shift of migrants from the western parts of their breeding ranges.

The Yellow Warbler migrates early, during the late summer period of ordinarily static weather. The count was small in all years except 1948, when the exceptional, strong NW cold front at the beginning of August evidently caused a considerable eastward shift and concentration along the west side of Lake Michigan. As a result the 1948 count exceeded the combined total for the other four years. The next largest count, in 1950, was evidently caused by the strong NW cold front in mid-August, which came too late in the Yellow Warbler migration to be as effective as the earlier cold front in 1948.

The 1950 counts of Cape May, Wilson's, and Bay-breasted warblers were larger than in any other year, and of Blackpolls not much less than in 1948. The Nashville Warbler was very abundant and much earlier than usual. Each of these species comprised a larger percentage of the total warbler count than in any other year. The mid-August 1950 cold front must have caused a southeast movement of these species. The 1947 counts of Blackpoll, Cape May, Bay-breasted, and Nashville warblers were lower than in any other year, both in numbers and percentages of total warblers, which contrasts with the large totals of 1950 and 1948, when early cold fronts favored their migration through the Chicago region.

Summary

This paper is a regional study of grounded night migrants, based on a daily census of birds in Lincoln Park, Chicago, during the autumn migrations of 1946 to 1950 inclusive. The writer concludes that the bird waves that characterize the autumn migrations, the wide variation in the season counts of the abundant species, and other features of the census record are due chiefly to variable weather conditions, and particularly to the invasion of the north-central states by cold fronts, followed by periods of strong northerly winds. During the five-year study period, without exception, every important autumn bird wave was associated with an advancing cold front. As a rule the big migration waves of a given species accompanied cold fronts in the early or middle part of that species' migration period. In each year the great bulk of the migration had passed Chicago even before the first freezing temperature occurred at Chicago, and before temperatures more than a few degrees below freezing had occurred at Winnipeg or anywhere south of Lake Superior. The birds seen later were chiefly Slate-colored Juncos, Fox Sparrows, Tree Sparrows, and Golden-crowned Kinglets.

The autumn migration waves are associated with cold fronts followed by strong NW to N winds. Cold fronts followed only by strong NE winds never brought migration waves to Lincoln Park and the census study produced no other evidence that birds migrate westward across Lake Michigan in any appreciable numbers. Conversely, it is believed that marked concentrations of birds migrating southeastward with NW winds occur along the west side of Lake Michigan. This results in a large count of birds at Chicago during subsequent days if later weather conditions do not cause a quick dispersal of the concentration. The large season counts of migrants passing through Lincoln Park are believed to be due chiefly to the southeast shift of birds migrating with NW winds, and resulting concentrations due to the barrier effect of Lake Michigan. Static weather conditions during the early and middle part of a species' migration period normally results in a low season count.

The migration of warblers (excluding the late-migrating Palm and Myrtle warblers) is presented as representative of the early part of the fall migration, which begins during the late summer period of normally static weather conditions. Much of the early migration usually passes before the strong cyclonic circulation of autumn is well established, generally about mid-September. But the early migrants do take advantage of any favoring cold front winds in their southward migration. Early cold fronts in late August and early September were always followed by important warbler migration waves. Above average warbler counts are evidently due largely to a favorable sequence of early cold fronts, with southeast shift of migrants from the western parts of their breeding ranges, just as in the case of the later migrants.

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